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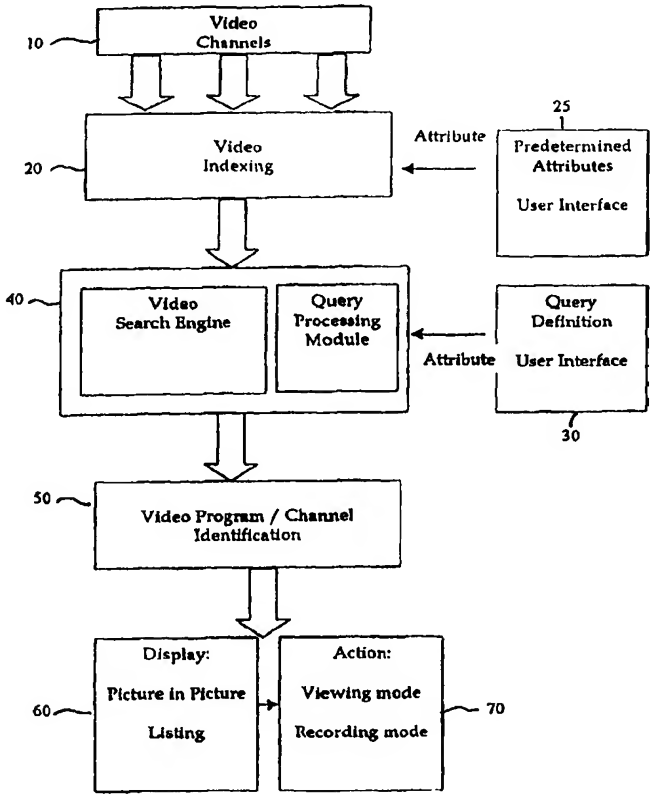
(57) Abstract

A method of selecting, at a video receiver location, a desired video program channel from a number of program channels (10) transmitting video programs, by: automatically generating, for each program channel, indexing data (115) of at least one predetermined attribute based on the video program content of the respective channel; specifying at least one attribute corresponding to a desired program content, such as a program title or the occurrence of any event within a program; and identifying, from the indexing data, any program channel having a match with respect to the attribute specified. Preferably, the indexing data (115) is generated at a remote location, is encoded and transmitted in a separate indexing channel for all the program channels, and is received and decoded at the receiver location, the attribute corresponding to a desired program being specified at the receiver location.



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A METHOD OF AUTOMATIC SELECTION OF VIDEO CHANNELS

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to multi-channel video / television systems and, in particular, to a method of providing viewers with automated selection of channels which match viewer's defined search criteria.

The number of video channels available over cable television systems and satellite television systems increases rapidly. Therefore, users need improved methods for selecting video channels that at a given time carry a preferred program and or content. Similar needs occur in video on demand systems, interactive television, and certain internet-television arrangements.

For years, viewers have relied on pre-printed television program listing. There are numerous disadvantages in using an external paper-based information source, which is updated usually once a week.

In recent years, television-based electronic program guides (EPG) have been developed. Program listing are displayed directly on the TV screen and provide better access and ease of updating as compared to pre-printed guides. Typically, the EPG is a scrolling TV program list that is transmitted over a dedicated cable channel. Viewers can tune to the guide channel and view information about programs being then transmitted or to be transmitted in the near future.

Another form of dedicated cable channel contains a split screen display of the other channels. A video combination device generates the display such that several video channels (say 16) are displayed concurrently. When the number of channels is greater than the capacity of a single display screen, several displays are time-toggled to cover the entire set of channels. However, the passive nature of this technique limits its value. Also, one cannot search by title, genre, channel or view listing for programs scheduled a few days ahead.

Several prior art methods are specifically directed to channel searching.

In some prior art methods, the search capabilities are manual and therefore disturb the viewing habit. Also, manual techniques are very limited in situations of hundreds of video channels.

In other prior art methods, automatic searching is based on pre-encoded textual descriptions of the video content. Such descriptions are subjective and usually very concise. Closed captions, which are encoded into the video signal, contain a transcription of the dialogues but do not relate to any visual information. Additionally, no provision is made for events that are happening in real time such as a sudden or dramatic event that is as "breaking news". Such event is probably not contained in the EPG data.

There exists a need for an improved television channel selection method, which employs automatic searching in video, based on the audio and video content of the television channels. There exists also a need for the method to match the viewer's preferences, specified as a query, with the content attributes of the television channels which are extracted automatically and in real-time from these channels.

BRIEF SUMMARY OF THE INVENTION

According to one aspect of the present invention, there is provided a method of selecting, at a video receiver location, a desired video program channel from a number of program channels transmitting video programs, comprising: automatically generating for each of the program channels, indexing data of at least one predetermined attribute based on the video program content of the respective channel; specifying at least one attribute corresponding to a desired program content; and identifying, from the indexing data, any program channel having a match with respect to the attribute specified.

According to further features in many of the described preferred embodiments, the indexing data is generated at a remote location, is encoded and transmitted in a separate indexing channel for all the program channels, and is received and decoded at the receiver location; and the at least one attribute corresponding to a desired program is specified at the receiver location.

According to still further features in the described preferred embodiment of the invention, the indexing data is collected from selected key-frames of the respective video program; and is tagged with a channel identification code and with a time tag. In addition, the indexing data from a plurality of channels is multiplexed into a data stream before transmission.

According to still further features in the described invention, the selection of the channel to be viewed may be "event-driven", as an extension of the prior art methods of "program-driven". Thus, the video material is segmented into multiple sets of "events", such as occurrences of people, objects, sounds and other; the occurrence of the events can be detected and presented to the viewer at the receiver location.

Thus, according to another aspect of the invention, there is provided a method for indicating at a video receiver location, the occurrence of a particular event when occurring on any number of program channels transmitting video programs, comprising: automatically generating at a remote location, for each of

the program channels, indexing data of the respective video programs; encoding and transmitting said indexing data for all the channels; receiving and decoding the indexing data; specifying at the receiver location the particular event when occurring on any of the programmed channels; and identifying, from the indexing data each occurrence of the particular event on any of the program channels.

According to further features with respect to this aspect of the invention, the specified event, when occurring on any of the program channels may be automatically displayed (e.g., as a picture within a picture) on the screen of the video receiver; and / or, may be recorded in a recorder.

According to one embodiment of the invention, the indexing data is transmitted in a separate indexing channel and is received and decoded at the receiver location. In a second described embodiment, the indexing data is used at a central control node for selecting programs to be transmitted to a plurality of viewer stations at a plurality of receiver locations according to the attribute specified at the respective receiver location.

According to another aspect of the present invention, therefore, there is provided a method of selecting, at a plurality of viewer locations, a desired video program from a plurality of video programs transmitted in a plurality of program channels, comprising: automatically indexing, at a remote location, attributes of each of the video programs transmitted in the program channels; transmitting said attributes of each of the video programs in the program channels; receiving, at a central control node, the video programs and the attributes thereof; specifying, at each of the viewer locations, particular attributes of a video program desired to be viewed at the respective viewer location; and utilizing, at the central control node, the attributes specified at the viewer location for identifying the video programs matching the specified attributes.

Thus, the system may include a central control node that receives the indexed data from the indexing channel and transmits programming over a network to multiple viewer stations (e.g. homes). The programming may include

standard analog video broadcasts (e.g., NTSC, PAL), digitally encoded video broadcasts (e.g. MPEG), or digital information related to computer-executed applications. Each viewer station includes at least one video display set (e.g., a television receiver) and an interactive station controller which is sometimes referred to as a set-top box. The interactive station controller at the viewer station specifies at least one attribute corresponding to a desired program to be viewed. The central control node then identifies from the indexed data received and decoded the channel representing the best match with respect to the content-based attribute specified and transmits the best-match channel to the receiver location.

In one described preferred embodiment, the content that is searched and detected may be stored in a recording device, enabling future viewing and programs/events statistics information gathering. In another described preferred embodiment, the data processor at the remote location generates indexing data that is stored in a web server in the internet.

According to a still further aspect of the present invention, there is provided a method of generating a program schedule of desired video program channels from a number of program channels transmitting video programs of various program contents, comprising: automatically generating, for each of the program channels, indexing data of at least one predetermined attribute based on the content of the programs to be transmitted on the respective channel, and the scheduled transmission time thereof; specifying at least one attribute corresponding to a desired program content; and identifying, from the indexing data, the program channels and the scheduled transmission times thereof, having a match with respect to the specified attribute to thereby produce a program schedule of the program channels.

Further features and advantages of the invention will be apparent from the description below.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. 1A is a block diagram illustrating an overall system in accordance with the present invention.

FIG. 1B illustrates a video channel selection system based on automatic searching by content according to one aspect of the present invention;

FIG. 2 illustrates a video channel selection system that includes a central control node;

FIGS. 3A and 3B depict a partitioning of a video program into high-resolution segments, or events;

FIG. 4 is a flow diagram of preferred steps for selecting video channel based on automatic searching by content:

FIG. 5 illustrates a video indexing data multiplexing and encoding device according to another aspect of the present invention;

FIG. 6 illustrates an automatic video indexer according to another aspect of the present invention;

FIG. 7 illustrates a search menu for defining a user query from pre-defined attributes of audio and video content:

FIG. 8 illustrates a sequence of video indexing data, which is a low-resolution representation of the respective video images;

FIG. 9 is a flow diagram of preferred steps for searching explosions in video based on visual content only;

FIG. 10 illustrates a data sequence of measurements characteristic of explosions:

FIG. 11 is a flow chart of a web-based television channel selection system based on automatic searching by content: and

FIGS. 12A, 12B and 12C illustrate the system used for producing a personalized program schedule; and

FIG. 13 illustrates the system used for computing topic-oriented video summaries of television channels according to one aspect of the present invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

This invention presents a method of selecting at a video receiver location, a desired video program channel from a number of program channels transmitting video programs. FIG. 1A presents an overview of the main system components. Video channels can be inputted from a variety of sources 10, including live video streams, as well as archived video material. For each of said program channels, indexing data is generated 20, of at least one predetermined attribute 25, based on the video program content of the respective channel. The method entails specifying at least one attribute corresponding to a desired program content 30. The attribute may be a desired program title, or an occurrence of an event within any program at any channel, as will be elaborated on and demonstrated below. While utilizing the indexed data and user input attributes, a search is conducted to detect a match of the program channels and the attribute specified 40. Multiple attributes may be specified, along with a set of relating conjunctions, in which case a match is detected when all attributes are present, and when the associated conjunctions are met. Once a match is detected, the related program and program channel is identified 50. Multiple program channels may be identified as having a match. The match scores may be sorted, in which case the identified program channels are identified as the "best match program channel", "second-best match channel", and so forth. Identified programs are presented to the viewer, e.g., as a picture-in-picture or as a scrolling listing on the main display screen 60. With this information in hand, the viewer may select an option such as the viewing of the identified program content, or the recording of the content 70. Viewer may select these options in an interactive operational mode, or may predetermine selected actions. The variations within the presented method for video channel selection will be discussed as well as possible system embodiments.

Reference is now made to FIG. 1B, which is a block diagram showing a first embodiment of the video channel selection system. For purposes of simplicity and clarity, the system is described with reference to widely available systems and standards, including conventional analog television receivers and

cable-based video networks. It will be appreciated, however, that the particular components of the channel selection system may be implemented with a variety of conventions, standards, or technologies without departing from the underlying concepts of the present invention. The term "video-channel selection system" is used to emphasize the applicability of the invention beyond standard television-based systems. The term "video" is used to describe both an audio-visual content and the image part of that content which consists of a sequence of images.

The system illustrated in FIG. 1B comprises two parts: one at the transmitter side, and the other at the receiver side. Generally, the transmitter side of the system can be located at the service provider's site, and the video indexing channels can be encoded and transmitted along with other channels. The receiver side includes at least one video display set (e.g., a television receiver) and an interactive station controller which is sometimes referred to as a set-top box.

The receiver side of the system can be located in a user's set-top cable converter box or other signal reception or processing device such as a satellite receiver. Alternatively, the components can be mounted in a separate housing or included as a part of the television receiver, VCR, personal computer or multimedia player.

The transmitter side consists of a set of similar processing paths, one for each video channel. Each such path takes a digital video bit-stream 110, such as an MPEG2 stream, and decodes the stream in a decoder unit 111, into a sequence of video images. The video feed for each channel may be a live program or a recording on tape. The programming may include standard analog video broadcasts (e.g., NTSC, PAL), digitally encoded video broadcasts (e.g. MPEG), or digital information related to computer-executed applications. Regardless of input format, the bit-stream is converted into a sequence of images and the associated sound track in order to enable indexing on a wide range of video attributes.

When the input for a specific television channel consists of a video signal 113, a video digitizer module 114 converts that signal into a digital representation of the sequence of images and the associated sound track in a format suitable for processing by the video indexer modules 115. The decoded or digitized video signals are encoded for transmission in the video indexer modules 115. The operation of each video indexer module 115 is described in detail in FIG. 6. In that described embodiment video indexing is based on key-frames (a subset of the original video frames), which are used as a representation for these original video frames. Video content is captured at frame rate of 25 frames or 30 frames per second (PAL or NTSC formats, respectively). Since the visual information content in video changes at slower rates, only a fraction of the video frames is retained, and the indexing data for content-attributes are automatically computed for these frames only. Although video-indexing data is related to key-frames, additional frames may be needed when computing this data. A specific example is in the case of motion where frames adjacent to each key-frames are analyzed to extracted motion attributes.

The key-frames and video indexing data of a number of selected channels are time multiplexed in multiplexer 116 (FIG. 1B) into at least one video index channel which is later processed to aid the user in television channel selection. The sparse nature of key-frames, coupled with the concise nature of video indexing data, allows multiplexing such frames and indexing data from multiple channels into a unified video index channel. All key-frames and associated indexing data are tagged with a channel identification code as well as a time-tag, so that channel-specific indexing data can be de-multiplexed and reconstructed at the receiver's side.

Video indexing data is preferably prepared at the transmitter side for the following reasons: The computational capacity of the set-top box or television receiver is limited; the indexing is done in a user-independent manner; and the bandwidth does not allow transmitting multiple channels to the receiver for indexing. Note that the "transmitter side" can be any central location, such as a cable head-end, as will be discussed below.

Since key-frames and indexing data depend on the content of each channel, multiplexer 116 is designed to handle several situations that may occur. One such situation is the occurrence of two or more key-frames at the same time. In such a situation key-frames are either dropped or re-encoded in a more concise manner.

FIG. 1B shows also a functional block diagram of the remote control handset 120 and set-top box controller 130 at the receiver side. The remote control handset 120 comprises: a query profile selection signal generator 121 that generates query profile selection signals in response to depression of suitable buttons: an automatic searching signal generator 122, and a regular channel changing signal generator 123 which generates channel changing signals in response to depression of the channel changing buttons.

The set-top box controller 130 at the receiver side further includes an indexing data decoder 131 in communication with the cable-company and connected to a video search engine 132 within controller 130. The latter further includes a channel selector 133 controlling a secondary channel receiver 134 within controller 130 in communication with the cable company. Controller 130 further includes a primary channel receiver 135, and a user interface 136.

FIG. 2 is a block diagram showing an alternate to the video channel selection system of FIG. 1B. In FIG. 2, the transmitter 200 and the receivers 210 are separated by a central control node 220. that includes a receiver 221, a server 222, a video search engine 223, and a transmitter 224. The receiver 221 receives the programs and indexed material from the transmitter 200. The server 221 stores the indexed material received from the transmitter 200. searches this material for specified attributes in the video search engine 223. and transmits programming over a network to the multiple viewer stations 210 (e.g. homes) via cable or wireless.

Each viewer station 210 includes a receiver 211. at least one video display set 212 (e.g., a television receiver), and an interactive station controller 213, e.g., that sometimes referred to as a set-top box. The server 222 in the central

control node 220 matches the indexed video material to a pre-allocated set of users. The users' preferences and search criteria are available at the server 211 by a user-controlled remote server within controller 213, and/or by automatic extraction of viewer preferences based on viewing-history profiles effected by the controller 213. The interactive station controllers 213 at the viewer stations also enable the viewers to specify at least one attribute corresponding to a desired program to be viewed. The central control node 220 then identifies, from the indexed data received and decoded, the channel representing the best match with respect to the content-based attribute specified by each user and transmits the best-match channel program to the receiver location of the respective viewer.

In the two embodiments described (FIG. 1B and FIG. 2), the channel selection (identification) process takes place in the set-top box (130) and the server in the central-control node (220), respectively. These units have access to the attributes coming from the receiver end, as well as the indexed data generated from the video channels. These units are then responsible for detecting any matches and identifying the respective channels, sorted by their match; specifically, identifying the channel representing the best match, and the channel of the next-best match. The two embodiments described represent two possible system architectures. In the one case, the indexed data is generated at a remote location, and transmitted to the receiver location, at which place the program identification is pursued. In the second case, the indexed data is generated at a remote location, transmitted to a centralized location (a central-control node), at which place the program identification is pursued and conveyed further to receiver locations. It should be noted that additional embodiments are possible, such as the generation of the indexing data locally at the server location; the detection of a match and identification of selected programs at a server location, which may be physically located with the video channel providers; and variations thereof.

An example is in news production houses that generate the video material, have indexing data generated in house, provide video material to

editorial rooms based on predefined attributes, or user-specified attributes – all within a localized architecture.

With the present invention, video material, both pre-recorded programs as well as live material (e.g. live footage coming in a news program), are automatically indexed for content. Channel selection is thus enabled based on live material as well as predefined program categories. Multiple channels are indexed simultaneously.

The term "content" refers to all visual and auditory information that is extracted and indexed automatically from the video streams, in addition to any manual annotation available (e.g. the program title, program category etc). Moreover, video content relates to the partitioning of video streams into segments that correspond with video "attributes". Attributes may represent video program *titles*, as known in prior art, in which case the corresponding video segments are full-length video program segments. In this invention, attributes may also represent the occurrence of "events" *within a program segment*, thus partitioning the program into higher-resolution segments of content. Hereon, the terms *attributes* and *events* are used interchangibly.

FIG. 3-A depicts a partitioning of a video program segment 300 into "event" segments. Examples of attributes and events include: object (e.g., people) events 310-313, sport-events (e.g., "goals" 320, 321), and news events (e.g., "breaking-news" events 330). Examples of other events that may be specified by a user include: action-movie events (e.g., explosions), sound events (e.g., President Clinton's voice), spoken-word events (e.g., words about politics or the economy), and text-events (e.g., segments that have material regarding a certain location and that location is present as overlayed text on top of the video segment). Events are detected and indexed across several video channels simultaneously, as shown in FIG. 3-B. The time axis is segmented into events as they occur ("event-driven"). Each event, indicated as a short line segment, is linked to the related channel /video source.

With this definition of content the selection of the channel to be viewed may be "event-driven", as an extension of the prior art methods of

"program-driven". Thus, the system enables searching video channels for attributes/events in addition to searching for full-length programs. Occurrences of the specified events are detected and presented to the viewer at the receiver location.

The user can predefine a table of attributes of interest. Alternatively, a viewer's preference list of search attributes, or a program viewing profile, may be learned from the user's viewing history.

An example of a user's attribute table, or a program and event list, is the following:

Category/Attributes	Programs/Events
News	CNN, NBC, ABC
Sports	NBA
News	"breaking news"
Sports	"Goal"
People	"Sharon Stone", "Clinton"
Words	"economy", "disaster"

The user may select a category of interest, such as news or sports; within each category, the user may define programs of interest such as CNN, NBC news. The user may choose attributes of interest, such as people or keywords, and particular events of interest, such as the appearance of "Sharon Stone" and "Clinton", or any words spoken about the "economy".

Combinations are possible within the selection criteria. The user may combine program categories with attribute events, such as selecting to see Pres. Clinton only on selected news programs (e.g. CNN); the user may add time constraints, such as selecting to be notified of events occurring during all evening news channels.

FIG. 4 is a flow diagram of preferred steps for selecting a television channel or any video channel based on automatic searching by content.

In step 410, video streams are received from multiple video channels. In step 420, key-frames are selected from each video channel, based on the video content in a manner that represents the content of the video in a concise and efficient way; based on the key-frames, additional indexing data, which are attributes related to the content of the video, are computed. In step 430, key-frames and indexing data from all indexed channels are encoded and combined into a much smaller number of indexing streams or files.

Steps 440 to 480 constitute a particular sequence for channel selection by the viewer according to the present invention. In step 440, the viewer receives a particular primary video signal to the television receiver or set-top box controller; the primary signal is usually displayed on the main video display. In step 450, key frames and video-indexing data generated as described above are transmitted to the set-top box controller; alternatively, the video-indexing data is transmitted to the server at a central node location as described above with reference to FIG. 2. In step, 460 a video query is defined by manipulating an on-screen menu; alternatively, such a query can be defined by the user in a more flexible or pre-programmed manner in the user's personal computer and downloaded to the receiver or set-top box controller or server at the central control node 210 of FIG. 2. Alternatively, viewer's preference list of search attributes is updated based on viewer's query history or viewing profile, and used for current search.

In step 470, the search results, (e.g., in the form of key-frames) from video channels other than the primary channel that match the video query, are displayed on a secondary display (such as a picture-in-picture (PIP) arrangement). Alternatively, results may be presented as a listing. The user can, as shown by step 480, select interactively either to switch the primary channel, or to record a video channel, according to the search results.

A functional description of a mutiplexing device for video indexing data for use as multiplexer 116, FIG. 1B, is illustrated in FIG. 5. Video indexing data 510 enters the video index multiplexer from a plurality of channels and is encoded by the indexing data encoder 520 for each channel. The parallel to

serial converter 530 serializes the encoded indexing data streams from the plurality of channels. The serial index data stream enters a FIFO buffer 540 and exits to an arbitration logic 550 designed to handle co-occurrence of key-frames in more than one channel. Then, the encoded indexing data goes through a bit rate controller 560 to produce the output time-multiplexed video indexing data.

The serialization of a number of data channels, the arbitration of key-frames, and the control of the data-rate, can be implemented by a number of prior art methods from the field of communications that are not specific to the present invention.

FIG. 6 describes an automatic video indexer that may be for video indexer 115 in FIG. 1B to select key-frames and to generate indexing data.

The audio-video data stream is first processed by a key-frame selection module 610 to produce a content summary. A number of prior-art methods for selecting key-frames are known. Most of them are based on detecting video shot transitions and selecting a frame from each shot (generally the first one) as a key-frame. In the presence of motion, more key-frames have to be selected to represent the content of video including the temporal variation. Co-pending Application No. PCT/IL99/00169 by the same assignee as the present application, describes a preferred method of selecting key-frames. In most types of video content, it is sufficient to select only a few percentage points of the original video frames to get a good representation.

While the summary, which consists of the video key-frames, can be used as a concise descriptor of the video content, more indexing information should be extracted to allow for efficient automatic searching. This is due to the following reasons:

- The key-frames contain raw image data, while video searching is done based on image attributes.
- Some attributes, such as image motion information, cannot be extracted accurately from key-frames alone.

- Practical limitations on the computing power inside set-top boxes require that video search engines inside such boxes will operate on concise indexing data.

Video indexing data is automatically computed from the video image sequence by video image indexing engines 620. Such engines may include a face detection engine 621, a motion indexing engine 622, a video text recognition engine 623, and / or a color indexing engine 624.

Audio indexing data is automatically computed from the audio track by audio indexing engines 630. Such engines may include: segmentation to silence, speech, music and effects 631; feature extraction for audio classification 632; and recognition of pre-programmed effects 633.

Prior art methods are known and may be used for implementing each of the above mentioned indexing engines 620 - 633.

Sometimes video streams carry video meta-data such as closed captions, and possibly encoded textual information such as annotations. Meta-data decoder 640 extracts this meta-data which is added to content-based indexing data. Manual annotations can also be added by annotation editor 650. In a live feed situation, the volume of such descriptions is limited due to time constraints. However, they provide additional information about the video content.

All video indexing data is time-stamped according to a global clock.

FIG. 7 illustrates a search menu 700 overlaid on the television display by a graphic generator that mixes the graphic video signal with the receiver video signal. The search menu consists of a set of content-based attributes such as visual attributes 710, audio attributes 720, topic-related attributes 730, and special attributes 740 such as breaking news or explosions. The search menu also includes a simple query language 750 that allows selecting "AND", "OR" and "NOT" control functions, for generating and displaying, in a display region 760, such queries as:

VISUAL = People AND AUDIO = Laughter

Such a search menu is simple to operate and requires only a minimal user-interface. However, the indexing data transmitted to the viewer can support a wide range of video queries. For that purpose, a computer-based interface can be used to define a set of queries on the viewer's personal computer and to download the set of queries to the set-top box. Once downloaded, these queries can be selected by the remote controller handset 120 (FIG. 1B). In other TV-PC combinations, the query definition is supported more easily.

As mentioned above, the method for computing attribute-specific indexing data and for querying these attributes can be implemented by methods known in the art. For illustrative purposes, a simple example is described below teaching how to search for explosions based on the video image track.

The search is implemented, as described in FIG. 9, by a combination of indexing and searching. Indexing 910 consists of decimating the key-frame sequence that is computing a low-resolution version of the images. Low-resolution color representations support a wide variety of color-based queries.

FIG. 8 shows a low-resolution frame sequence obtained by decimating the key-frame sequence.

Searching for explosions in the indexing data is performed by computing the "fire magnitude" 920 at each frame. The fire magnitude value is computed by summing a quantity inversely related to the color distance from a pre-specified fire color value, over all pixels in the low-resolution image as shown by blocks 930 and 940 in FIG. 9. FIG. 10 shows the fire magnitude for the sequence of FIG. 8. The concise one-dimensional fire-magnitude sequence is processed by a derivative and threshold logic 950 to decide on a candidate explosion event.

The present invention can be implemented in additional embodiments other than those described above in which the multi-channel video indexing data are transmitted to the set-top box controller (FIG. 1B), or to a central control node (FIG. 2) that conducts the searching.

Thus, the automatic television channel selection may be implemented over the Internet as illustrated in FIG. 11, wherein a set of video channels are indexed by content by the combination of a digital video decoder 1110 and a video indexer 1120 for each of the indexed channels. The index data is stored in a web server 1130 on the Internet 1131. The web server uses an Internet TCP/IP protocol to make the indexing data available to users at the PC and TV combinations 1140, 1150, 1160 and 1170.

Because of the growing overlap between the TV, the personal computer and the Internet, more configurations now support data integration between these elements. Several such configurations are illustrated in FIG. 11. These include: the configuration 1140 of TV viewing on a personal computer 1141 that has at least one TV tuner 1142 but is also connected to the Internet; the configuration 1150 of Internet-capable set-top boxes 1151 with a video- search engine 1152, and at least one TV tuner; the configuration 1160 of a computer connected directly to the television receiver, and the configuration 1170 of a personal computer only. Streaming video via an Internet connection, such as a broadband connection, is a replacement for a television signal connection.

Video streaming over the net is becoming more and more a reality, for example in "broadcast.com". Users of such sites are presented with listings of broadcast (video) material from multiple broadcast (video) channels. Video may be viewed and downloaded. With the present invention, users of such sites will be able to benefit from "event-driven" information, with program content provided by content-providers sorted according to viewer's preference lists, and all other additional characteristics that are described herein. In figure 11, the broadcast content is streamed via an Internet broadband connection. The user can select a user profile, formulate a query or provide a username for selection of previously defined search criteria. In a preferred embodiment, search results in the form of a listing of the currently available channels that meet the user-defined criteria, or a thumbnail presentation of the content of these channels in the form of updating key-frames can be put by the web-server as an HTML page and sent to the user.

By clicking on at least one list item or one channel key-frame window, the selected video stream is buffered and played on the user terminal.

The identification of a channel meeting user-defined criteria is a process of finding a match between attributes in user-input query, or predefined attribute listing, and the indexed data. In case of multiple attributes and conjunctions, a match score may be given in reference to the number of attributes and conjunctions met (for example, the number of elements present). Alternatively, an all-or-nothing scheme may be used, in which a match is defined when all attributes and conjunctions are met, otherwise no match. Multiple matches correspond to multiple channels. Prioritizing between the channels may be introduced by utilizing the relative match scores; alternatively, viewer may set relative weights to the set of user-defined attributes; alternatively video programs may be prioritized utilizing a viewer program preference table and history profile.

Once a video channel is automatically identified as containing the category and attribute of interest, the information may be conveyed to the viewer at the receiver location in several ways. In one embodiment the program (or a keyframe program representation) may be displayed in a secondary video display window as a picture-in-picture (PIP). A variety of PIP settings are known in the art. These may include partitioning of the main video display window into several smaller windows surrounding the main display, or a secondary display window as a small window top right, and others. In another embodiment, program identification is displayed as a listing on part of the display window. Program identification may include the program title (e.g. "CNN"), any defining attributes ("breaking news" segment) and any additional information desired (e.g., in a pay-per-view channel: "selecting this channel will cost X per hour"). In yet another embodiment, a signal may be used (such as a blinking signal or a sound signal) to notify of an event.

Following a channel identification event, the user at the receiver location may select via the controller 213, FIG. 2, one of several action items, including a viewing option and a recording option. In the viewing option, the user may select to switch over to a full-screen view of the selected channel. In

the recording option, the user may select to record the content. The viewer may choose to select amongst these options interactively, following the notification of an event; alternatively, the viewer may decide on a fixed setting (e.g. record all events occurring during the 6-8pm time slot). For example, while a viewer is watching the sports channel, the viewer is notified in a picture-in-picture setting that there is a "breaking news" segment in the CNN channel whereupon the viewer may decide to select the CNN channel for viewing; alternatively, the "breaking news" may be automatically recorded.

A variety of techniques exist in the prior art that enable channel selection based on specific programs or categories, as selected by the viewer. Interactive television systems establish a database of viewer preferences based on particular characteristics previously delivered to the viewer. The system compares the viewer preference list to the video programming available at the selected time, and identifies the video programming which has the greatest degree of correlation. The main goal is to generate a personalized channel guide based on program preferences and times personalized for the individual viewer. An example of such a guide is shown in the following table:

	8:00-8:30	8:30-9:00	9:00-9:30	9:30-10:00
Sports	Soccer Game		NBA	
Drama	Gone with the Wind			
News	CNN	NBC	ABC	

In the present invention, an "event-driven" electronic program guide (EPG) can be generated. A block diagram for generating the event-driven EPG listing is shown in FIG 12-A. Video indexing data 1210 (generated based on a

set of predefined attributes) and user-specified attributes 1211,1212 are processed by a video search engine 1213, and the resultant program/events schedule is displayed in a listing 1214. The listing may be a scrolling listing, allowing the viewer to follow in real time, the video content from a number of channels, such that the content matches specific topics of interest. The listing may also entail future scheduled programs and events, in which case the listing entails programs and events, channel identification and time segments (such as the beginning and the end time of the segment of interest). Schedules of events that are non real-time are generated for any video material available that is non real-time material. An example of an event-based EPG real-time scrolling listing is shown in FIG. 12-B. At each time in which there is one or more identified matches, the identified events are listed along with the corresponding video channel identifications. The continuous scrolling listing of the events may be presented on a small portion of the main display screen, or as a buffered secondary screen. The viewer may be interested in future scheduling. A variety of scheduling screens are available to the viewer, as shown in FIG. 12-C. The display screens include a display that is channel based (for each channel, time schedule and attributes are listed), or a display that is time schedule based (time segment is listed, together with the attribute/event and corresponding program identification).

The event-driven electronic program guide may be generated as a personalized guide, personalized to the particular viewer attributes 1212. The event-driven electronic program guide may be generated as a global listing, containing all attributes, as chosen by the respective video channel providers, or predefined in the centralized control server, or as combined across multiple user preferences, 1211.

Referring to the two embodiments of FIG. 1B and FIG. 2, the indexing data for each of the program channels could be generated in the video indexing modules 115 or in the central control node 220, respectively. The video search engine and channel selection units, at the set-top box 130, alternatively, the server at the central control node 220, identify from the indexing data the

program channels to transmit programs, and the scheduled transmission times thereof, having a match with respect to the specified one or more attributes, to thereby produce a program schedule. The personalized attributes may be input via the remote control handset 121 or user interface in the set-top box 136, or alternatively, the controller 213 at each viewer station 210 could be used for specifying one or more attributes corresponding to desired program content data. The global set of attributes by which a schedule is generated, may be derived at the server 222 in the central control node 220. The global set can be extracted from a set of attributes as chosen by the video content providers, or by collecting attributes from a set of viewers, or by utilizing a history profiling of the viewers, or via some combination logic of the personalized attributes lists.

Generating a viewing history profile for a viewer may include storing a viewer preference database of programs viewer selects or receives, as known in prior art. In this invention, attributes and events are incorporated in the profiling. The handset 120 in FIG. 1B, or the controller 213 in FIG. 2 at the receiver location, may generate and store a viewing-history profile of the programs viewed and the attributes requested at the respective receiver location. Such history profile may be utilized for prioritizing the programs identified, e.g., in the server 222 of the central control node 220 having the attributes specified by the respective user at the receiver location.

In recent years, smart TV, or "time-shifted" TV have been developed which, via recording systems that use hard-drives and computer chips, record and store television programming so that people can watch whatever they want, whenever they wish. With such recording devices, the viewer at home may choose between viewing a selected channel and recording it. The present invention may also be used in such systems to record content-based events from a plurality of channels according to designated events or events based on history-profile preferences.

A yet additional application of the invention is to generate a report of program and event statistics. A professional user may be interested to gather appearance statistics for a particular logo of interest or a particular clip, for

example. In this scenario, the event of interest is the logo (clip). This event is automatically indexed in the transmitter side and the indexed channel is received by the receiver (FIG. 1B) or by the server at the central control node (FIG. 2). Any indexed event is recorded in the recording device (as known in prior art). At the end of a specified time period (e.g., several hours, one day, night shows etc), statistics may be gathered. Examples are: number of occurrences per channel, overall time allocated in all segments, and so forth.

FIG. 13 is a flow diagram illustrating a method for generating topic-oriented video summaries (block 1310). In this method, video key-frames and video indexing data are processed by a video search engine 1311, and the query results are arranged in a storyboard, multi-frame display 1312. This display allows the viewer to follow, in real time, the video content from a number of channels, such that the content matches specific topics of interest.

The topic summary engine 1310 is similar in implementation to the channel selection method taught by the present invention and includes a query processing module 1313 communicating with a query definition user interface 1314. However, the purpose of the system in FIG. 13 is to allow topic-oriented multi-channel browsing rather than to select a specific channel.

The present invention can thus be applied to various arrangements where the user of viewer can select between multiple video or multimedia programs. Such arrangements include broadcasting, webcasting and other internet-television implementations, telecasting, video on demand, near video on demand, and interactive television.

While the invention has been described with respect to certain preferred embodiments, it will be appreciated that these are set forth merely for purposes of example, and that many other variations, modifications and applications of the invention may be made.

What is Claimed is:

1. A method of selecting, at a video receiver location, a desired video program channel from a number of program channels transmitting video programs, comprising:

automatically generating, for each of said program channels, indexing data of at least one predetermined attribute based on the video program content of the respective channel;

specifying at least one attribute corresponding to a desired program content;

and identifying, from said indexing data, any program channel having a match with respect to the attribute specified.

2. The method according to claim 1, wherein said indexing data is generated at a remote location, is encoded and transmitted in a separate indexing channel for all said program channels, and is received and decoded at said receiver location; and wherein said at least one attribute corresponding to a desired program is specified at said receiver location.

3. The method according to claim 2, wherein said indexing data from a plurality of channels is multiplexed into a data stream before transmission.

4. The method according to claim 1, wherein said indexing data is generated from selected key-frames of the respective video program.

5. The method according to claim 1, wherein said indexing data is tagged with a channel identification code and with a time tag.

6. The method according to claim 1, wherein said generated indexing data includes both image and audio attributes.

7. The method according to claim 1, wherein one program channel is identified having the best match with respect to the attribute specified, and at least one additional program channel is identified having the next-best match with respect to the specified attribute.

8. The method according to claim 1, wherein, in order to assist specifying at said receiver location said at least one attribute corresponding to a

desired program content, there is displayed, at said receiver location, a search menu setting forth a plurality of different attributes selectable by the user.

9. The method according to claim 8, wherein there are also displayed "AND", "OR" and "NOT" control functions also selectable by the user.

10. The method according to claim 1, wherein at least one of said attributes is the occurrence of an explosion in the video program, said indexing data including characteristic data indicative of fire-like color distribution in selected frames of the respective video program.

11. The method according to claim 1, wherein the generated indexing data is stored in a web server in the internet.

12. The method according to claim 1, wherein the program channel best matching the specified attribute is displayed as a picture within a picture on the screen of the video receiver.

13. The method according to claim 1, wherein the identification of the program channel matching the specified attribute is displayed on the screen of the video receiver.

14. The method according to claim 1, wherein the program channel matching the specified attribute is recorded.

15. The method according to claim 1, wherein a viewer at the receiver location preselects, via a user interface, whether a program channel identified as having a match with a specified attribute is to be recorded or to be immediately displayed on a video receiver at the receiver location.

16. The method according to claim 1, wherein said at least one predetermined attribute is used for generating a program guide setting forth a program schedule of channels to contain a video program content based on said at least one predetermined attribute.

17. The method according to claim 1, wherein said at least one specified attribute includes a particular event desired to be identified if occurring on any of said program channels.

18. The method according to claim 1, wherein said indexing data is transmitted in an indexing channel and is received and decoded at said receiver location.

19. The method according to claim 1, wherein said indexing data is used at a central control node for selecting programs to be transmitted to a plurality of viewer stations at a plurality of receiver locations according to the attribute specified at the respective receiver locations.

20. The method according claim 19, wherein said indexing data is transmitted in an indexing channel to said central control node.

21. The method according to claim 19, wherein said central control node also uses said indexing data together with a history-profile of at least some of said viewer stations, for listing the programs to be transmitted to the respective viewer stations.

22. The method according to claim 1, wherein the video receiver location generates and stores a history-profile of programs viewed at said video receiver location, and utilizes said history-profile for prioritizing the identified programs having the attribute specified.

23. The method according to claim 1, wherein the video receiver location or the server at a central control node, generates a statistical report of occurrences of said specified attribute.

24. The method according to claim 1, wherein the specified attribute relates to a particular topic of interest, and said video receiver location or the server at the central control node, generates a summary of occurrences of said topic of interest in the video channels.

25. A method for indicating at a video receiver location, the occurrence of a particular event when occurring on any of a number of program channels transmitting video programs, comprising:

automatically generating at a remote location, for each of said program channels, indexing data of the respective video programs;

encoding and transmitting said indexing data for all said channels;

receiving and decoding said indexing data;

specifying at said receiver location said particular event; and

identifying from said indexing data each occurrence of the particular event on any of the program channels.

26. The method according to claim 25. wherein said indexing data is transmitted in a separate indexing channel and is received and decoded at said receiver location.

27. The method according to claim 25, wherein said indexing data is used at a central control node for selecting programs to be transmitted to a plurality of viewer stations at a plurality of receiver locations according to the attribute specified at the respective receiver location.

28. A method of selecting, at a plurality of viewer locations, a desired video program from a plurality of video programs transmitted in a plurality of program channels. comprising:

automatically indexing, at a remote location, attributes of each of said video programs transmitted in said program channels;

transmitting said attributes of each of said video programs in said program channels;

receiving, at a central control node, the video programs and the attributes thereof;

specifying, at each of said viewer locations, particular attributes of a video program desired to be viewed at the respective viewer location; and

utilizing, at said central control node, said attributes specified at said viewer location for identifying the video programs matching said specified attributes.

29. The method according to claim 28, wherein said attributes of each of said video programs in said program channels are transmitted in a separate indexing channel.

30. The method according to claim 29. wherein said central control node also uses said attributes transmitted in said indexing channel, together with a history-profile of at least some of said viewer stations, for listing the programs to be transmitted to the respective viewer station.

31. A method of generating a program schedule of desired video program channels from a number of program channels transmitting video programs of various program contents, comprising:

automatically generating, for each of said program channels, indexing data of at least one predetermined attribute based on the content of the programs to be transmitted on the respective channel, and the scheduled transmission time thereof;

specifying at least one attribute corresponding to a desired program content;

and identifying, from said indexing data, the program channels and the scheduled transmission times thereof, having a match with respect to the specified attribute to thereby produce a program schedule of said program channels.

32. The method according to claim 31, wherein said indexing data is generated at a remote location, and is encoded and transmitted in a separate indexing channel for all said program channels.

33. The method according to claim 31, wherein said indexing data is received, decoded, and utilized at a receiver location for identifying the program channels to transmit programs having a match with respect to the specified attribute, and the scheduled transmission times thereof.

34. The method according to claim 31, wherein said indexing data is received, decoded, and utilized at a central control node for identifying the program channels to transmit programs having a match with respect to the specified attribute, and the scheduled transmission times thereof.

35. The method according to claim 31, wherein a plurality of attributes are specified each corresponding to a desired program content, and each program having a match with a specified attribute is identified and included, together with its scheduled transmission time, in said program schedule.

36. The method according to claim 1, wherein said video receiver is a computer connected to the Internet.

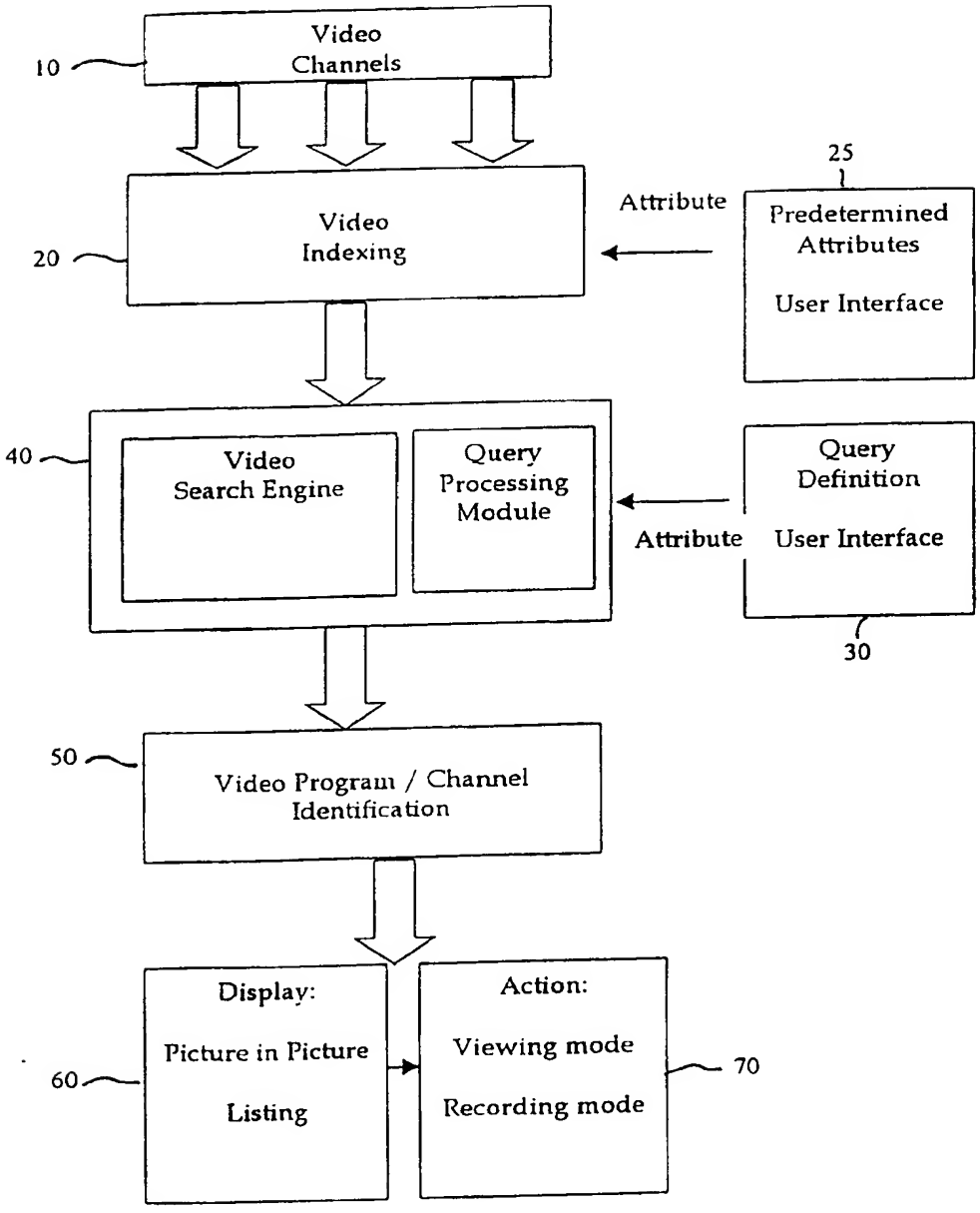
Video Channels
10
Video Indexing
20
Attribute
25
Predetermined Attributes
User Interface
40
Video Search Engine
Query Processing Module
Query Definition
Attribute
User Interface
30
50
Video Program / Channel Identification
Display:
Picture in Picture
Listing
60
Action:
Viewing mode
Recording mode
70

FIG 1-A

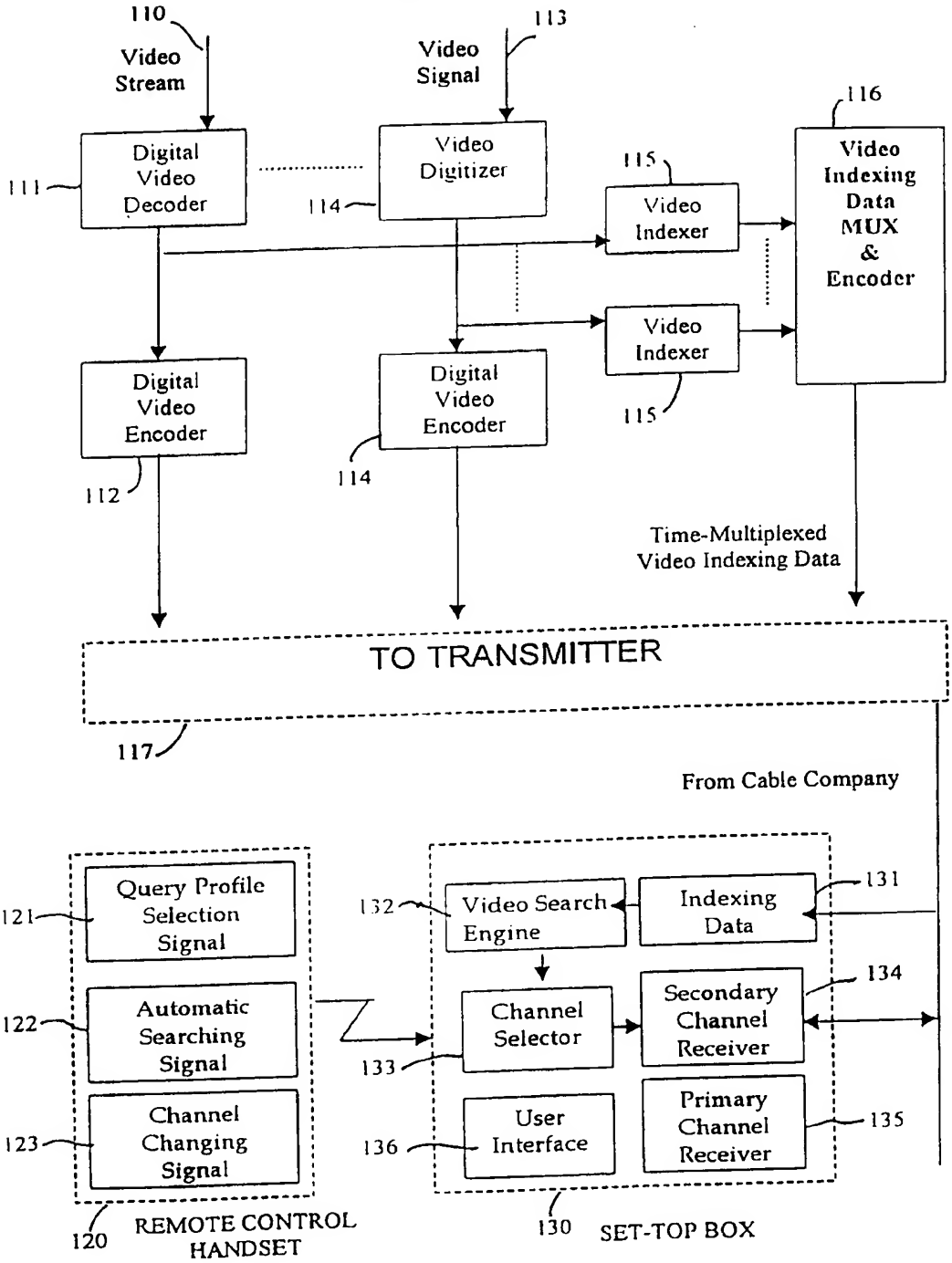
110
Video Stream
113
Video Signal
116
Digital Video Decoder
111
Video Digitizer
114
115
Video Indexer
Video Indexing Data MUX & Encoder
Video Indexer
115
Digital Video Encoder
112
Digital Video Encoder
114
Time-Multiplexed Video Indexing Data
TO TRANSMITTER
117
From Cable Company
Query Profile Selection Signal
121
Automatic Searching Signal
122
Channel Changing Signal
123
REMOTE CONTROL HANDSET
120
132
Video Search Engine
Indexing Data
131
Channel Selector
133
Secondary Channel Receiver
134
User Interface
136
Primary Channel Receiver
135
SET-TOP BOX
130

FIG 1-B

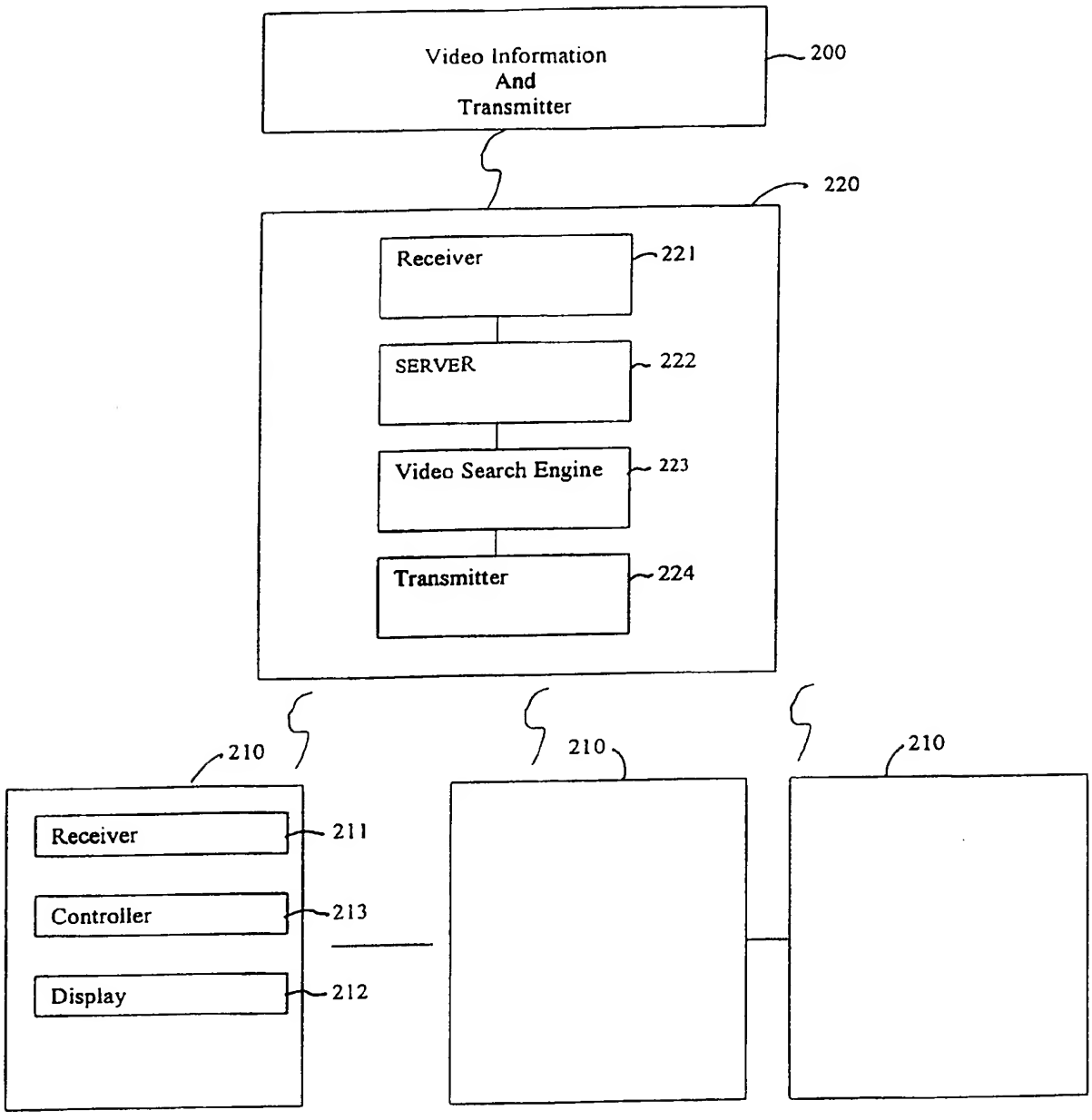
Video Information
And
Transmitter
200
220
Receiver
221
SERVER
222
Video Search Engine
223
Transmitter
224
210
210
210
Receiver
211
Controller
213
Display
212

FIG 2

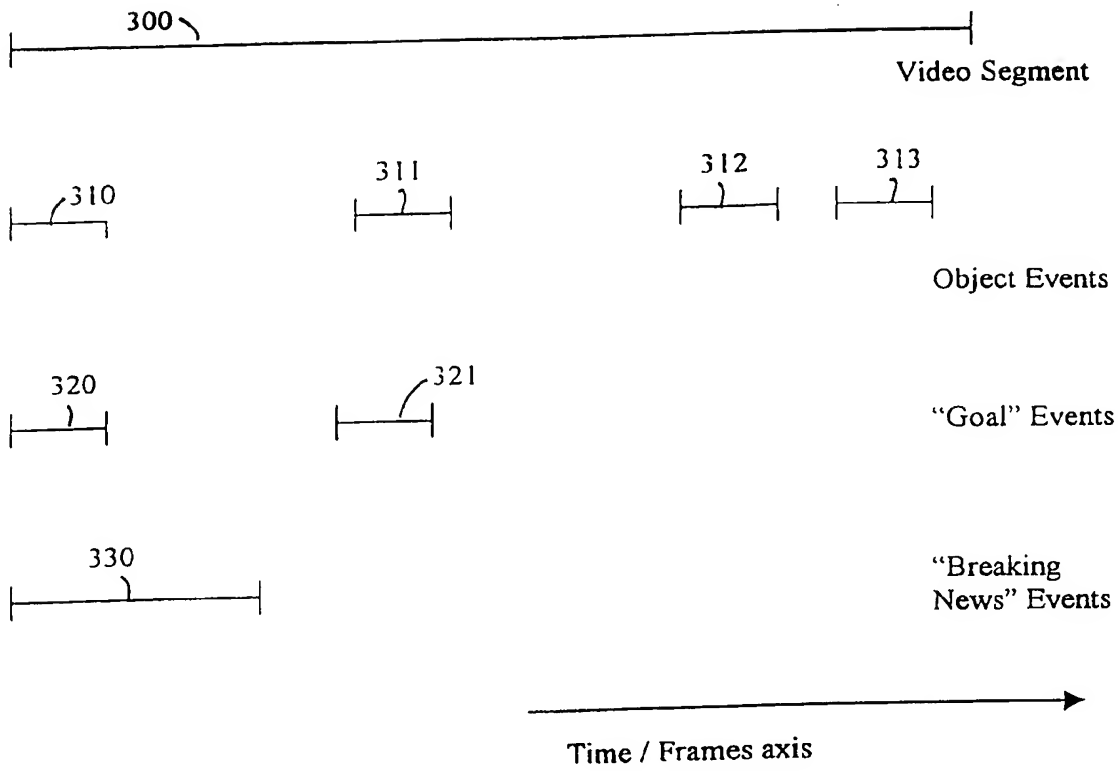
300
Video Segment
310
311
312
313
Object Events
320
321
"Goal" Events
330
"Breaking News" Events
Time / Frames axis

FIG 3-A

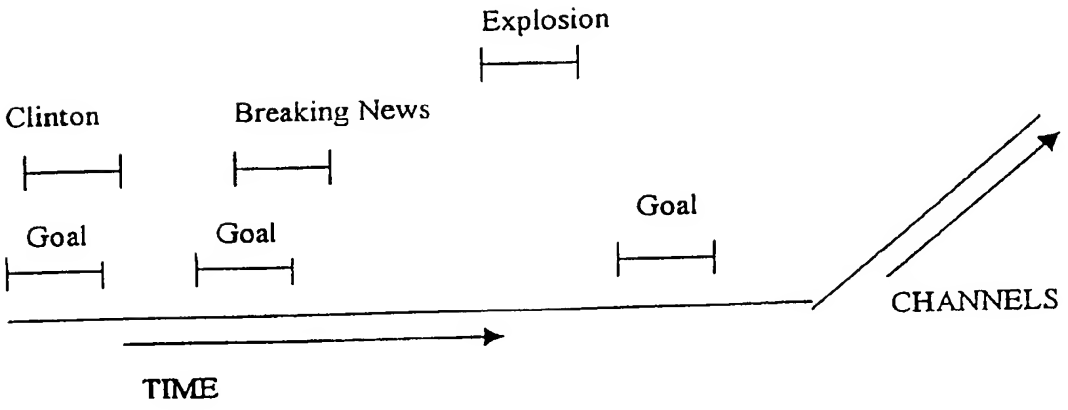
Explosion
Clinton
Breaking News
Goal
Goal
Goal
CHANNELS
TIME

FIG 3-B

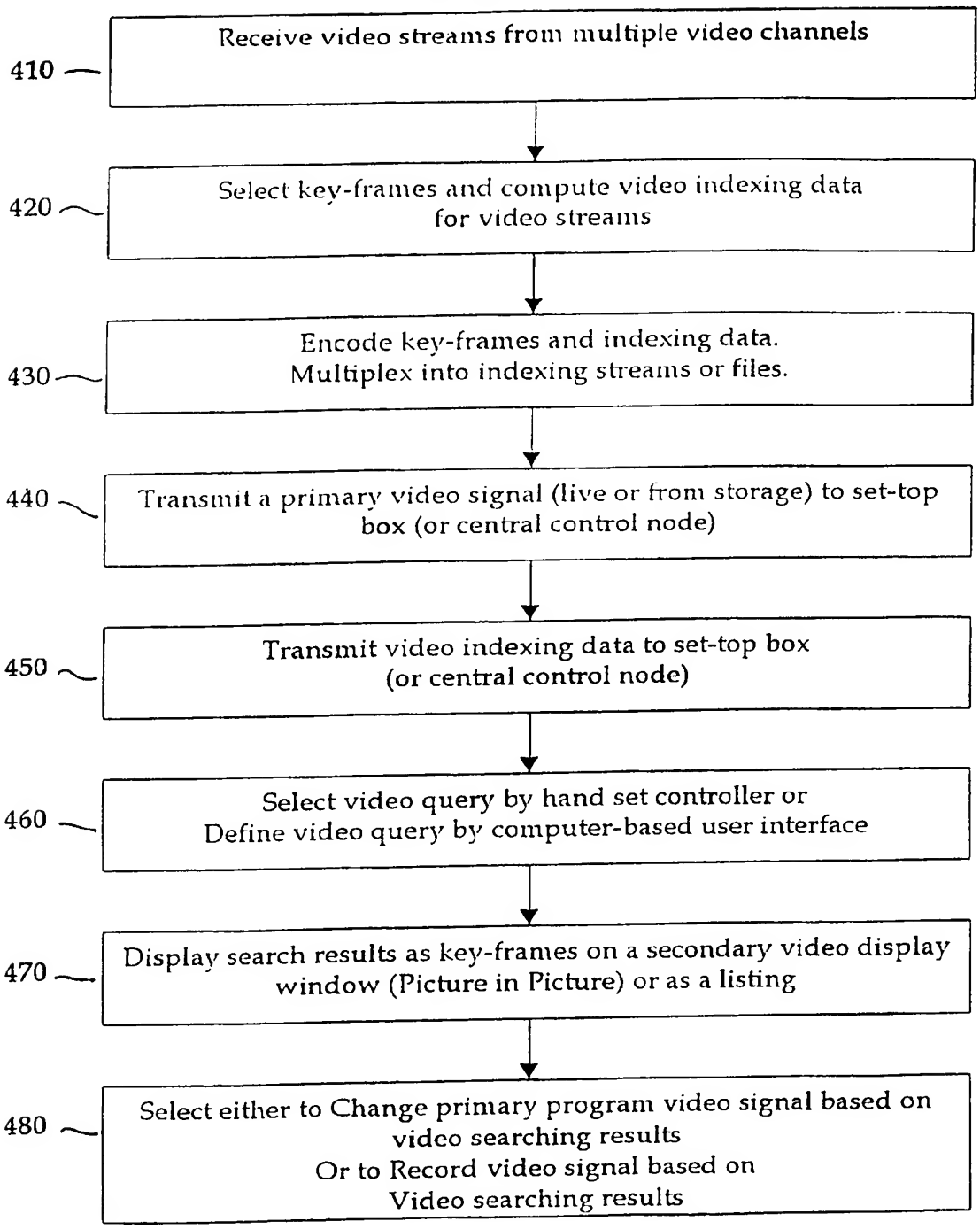
410
Receive video streams from multiple video channels
420
Select key-frames and compute video indexing data for video streams
430
Encode key-frames and indexing data. Multiplex into indexing streams or files.
440
Transmit a primary video signal (live or from storage) to set-top box (or central control node)
450
Transmit video indexing data to set-top box (or central control node)
460
Select video query by hand set controller or Define video query by computer-based user interface
470
Display search results as key-frames on a secondary video display window (Picture in Picture) or as a listing
480
Select either to Change primary program video signal based on video searching results Or to Record video signal based on Video searching results

FIG 4

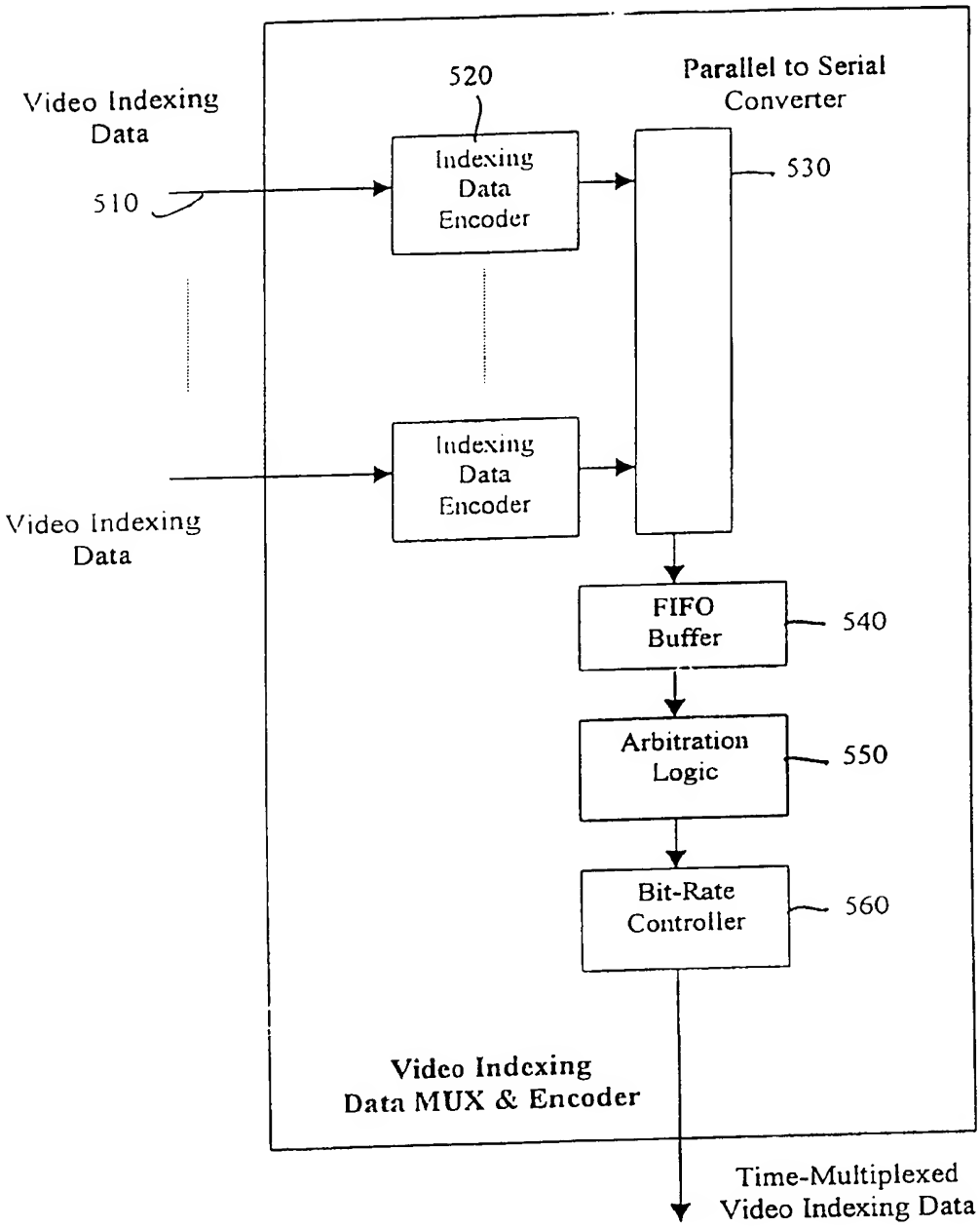
Video Indexing Data
510
520
Indexing Data Encoder
Parallel to Serial Converter
530
Indexing Data Encoder
Video Indexing Data
FIFO Buffer
540
Arbitration Logic
550
Bit-Rate Controller
560
Video Indexing Data MUX & Encoder
Time-Multiplexed Video Indexing Data

FIG 5

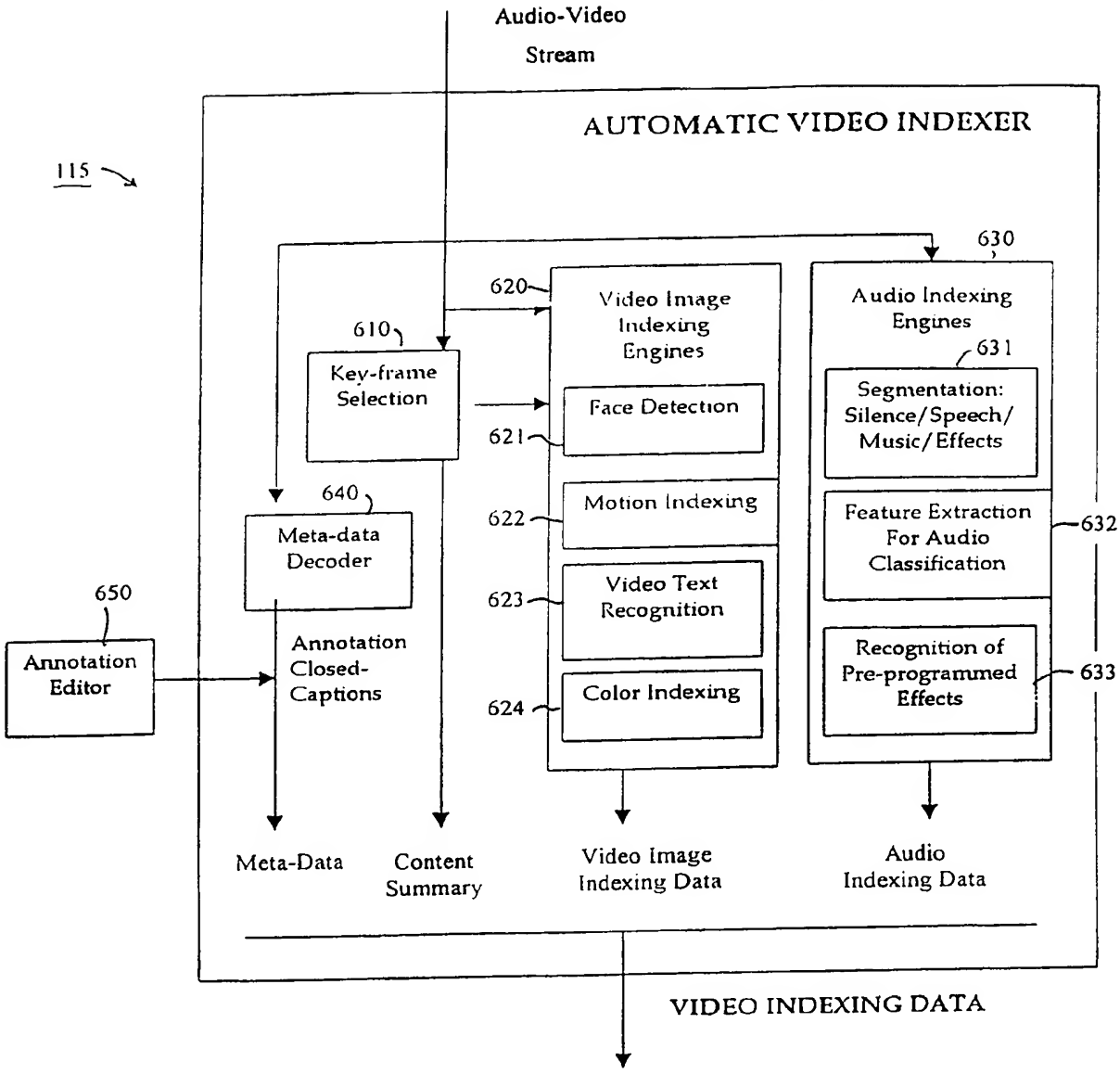
Audio-Video
Stream
AUTOMATIC VIDEO INDEXER
115
630
620
Video Image
Indexing
Engines
Audio Indexing
Engines
610
Key-frame
Selection
631
Face Detection
Segmentation:
Silence/Speech/
Music/Effects
621
640
Motion Indexing
622
Meta-data
Decoder
Feature Extraction
For Audio
Classification
632
650
Video Text
Recognition
623
Annotation
Editor
Annotation
Closed-
Captions
Recognition of
Pre-programmed
Effects
633
Color Indexing
624
Meta-Data
Content
Summary
Video Image
Indexing Data
Audio
Indexing Data
VIDEO INDEXING DATA

FIG 6

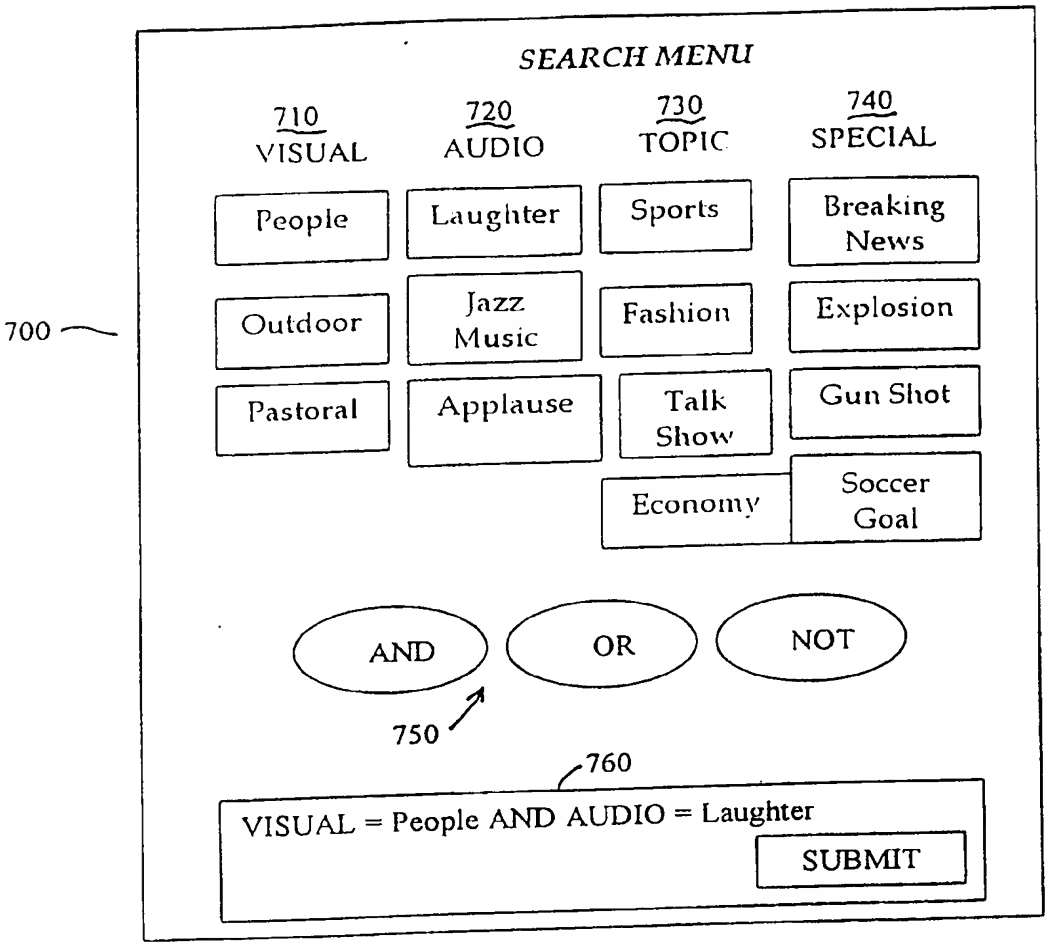
SEARCH MENU
710 VISUAL
720 AUDIO
730 TOPIC
740 SPECIAL
People
Laughter
Sports
Breaking News
Outdoor
Jazz Music
Fashion
Explosion
Pastoral
Applause
Talk Show
Gun Shot
Economy
Soccer Goal
AND
OR
NOT
750
760
VISUAL = People AND AUDIO = Laughter
SUBMIT
700

FIG 7

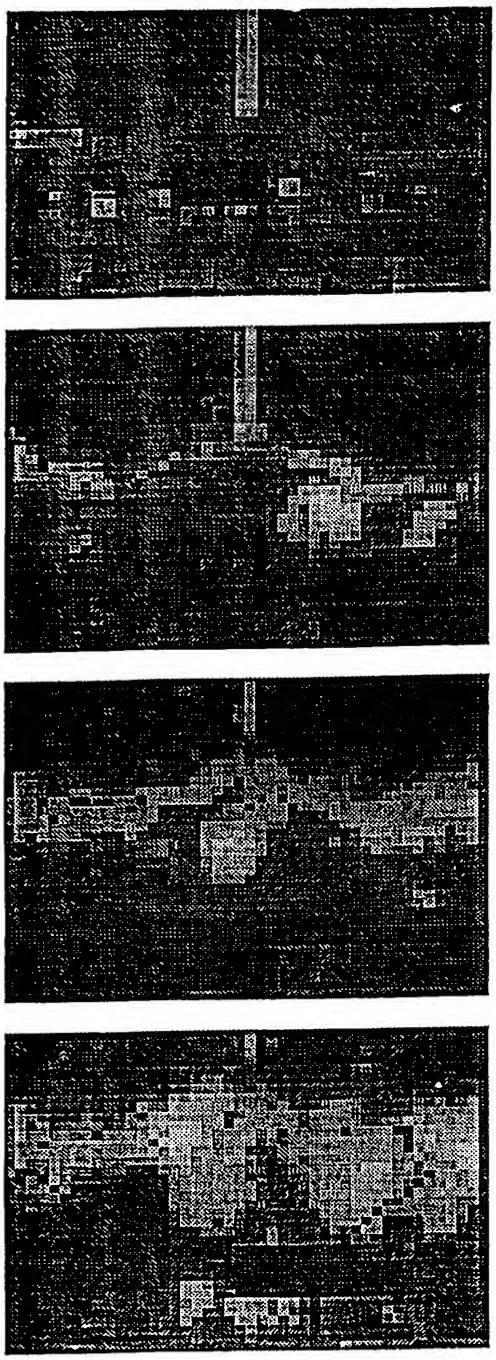

FIG 8

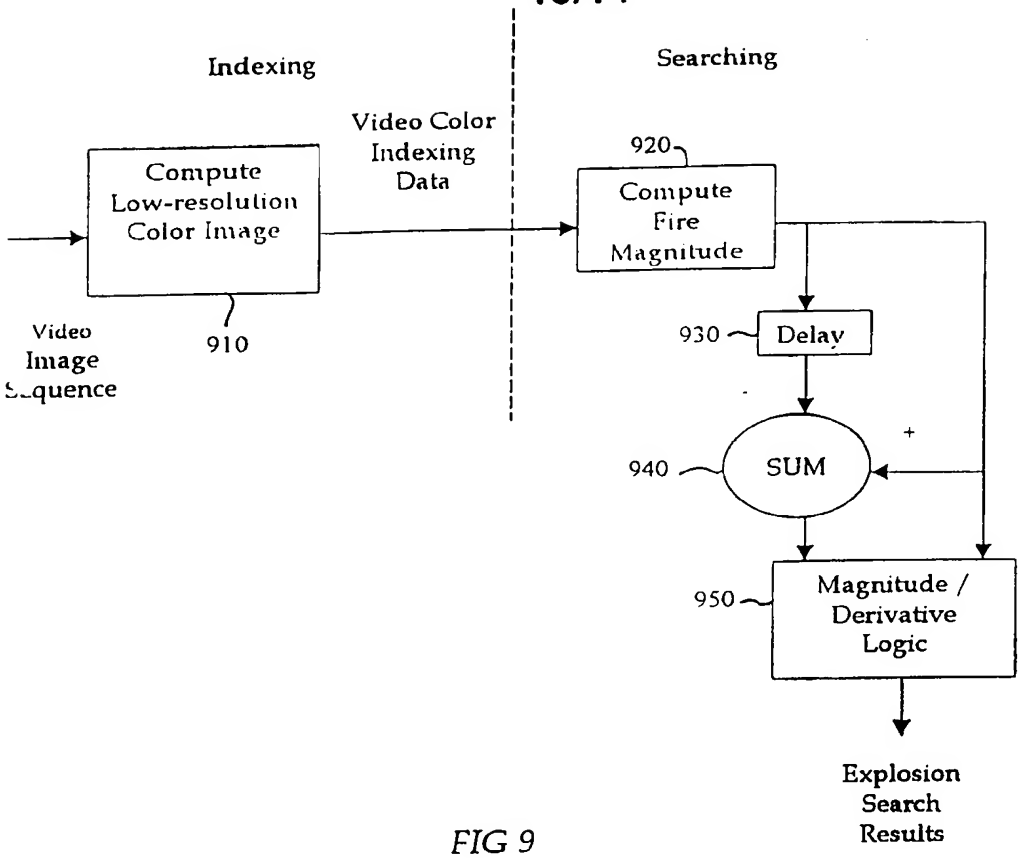
Indexing
Searching
Video Color Indexing Data
Compute Low-resolution Color Image
910
Video Image Sequence
920
Compute Fire Magnitude
930
Delay
940
SUM
+
950
Magnitude / Derivative Logic
Explosion Search Results

FIG 9

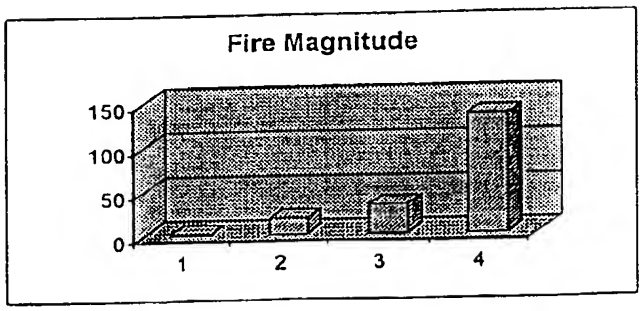
Fire Magnitude
150
100
50
0
1
2
3
4

FIG 10

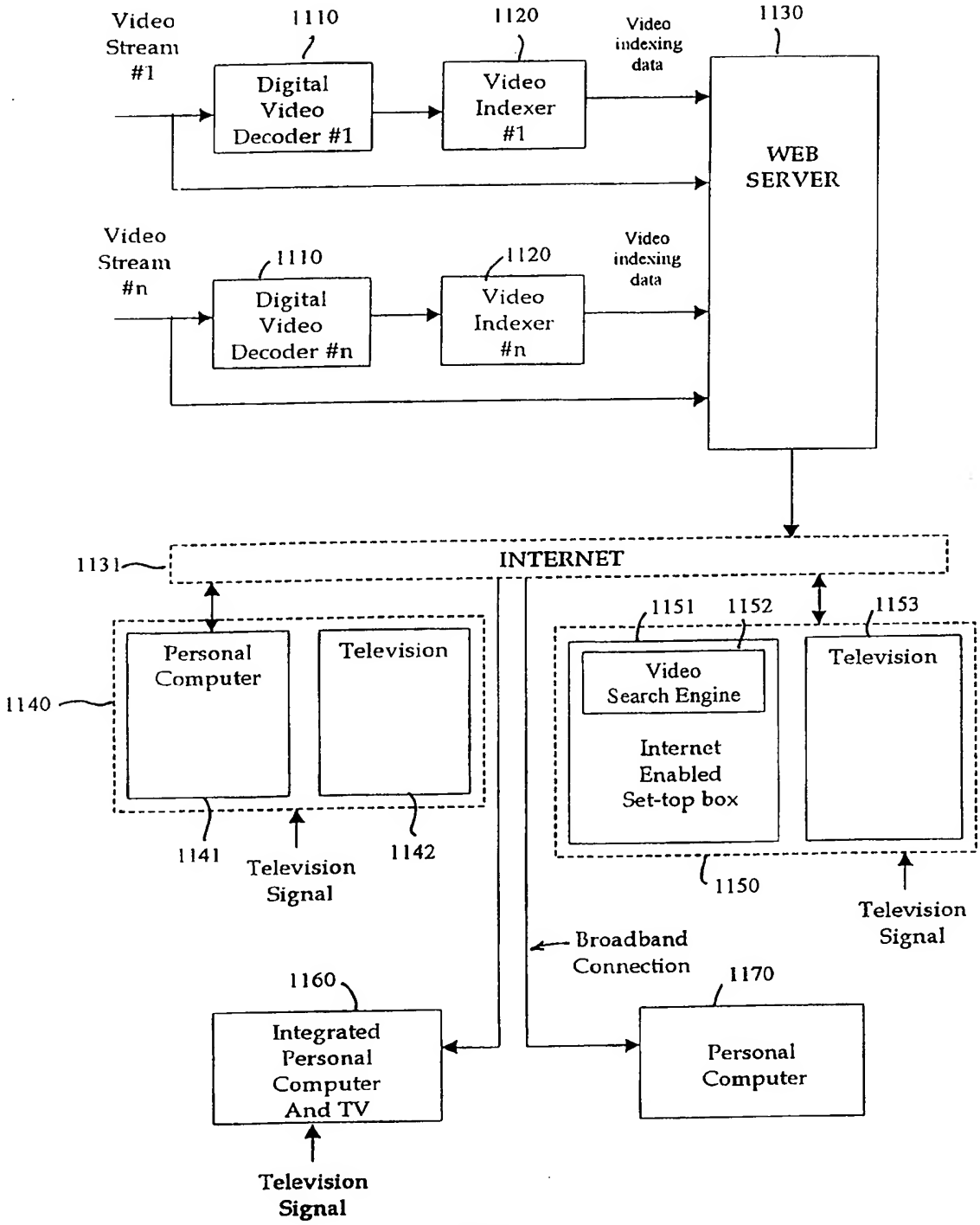
Video Stream #1
1110
Digital Video Decoder #1
1120
Video Indexer #1
Video indexing data
1130
WEB SERVER
Video Stream #n
1110
Digital Video Decoder #n
1120
Video Indexer #n
Video indexing data
1131
INTERNET
1140
Personal Computer
Television
1141
1142
Television Signal
1151
1152
1153
Video Search Engine
Internet Enabled Set-top box
Television
1150
Television Signal
Broadband Connection
1160
Integrated Personal Computer And TV
1170
Personal Computer
Television Signal

FIG 11

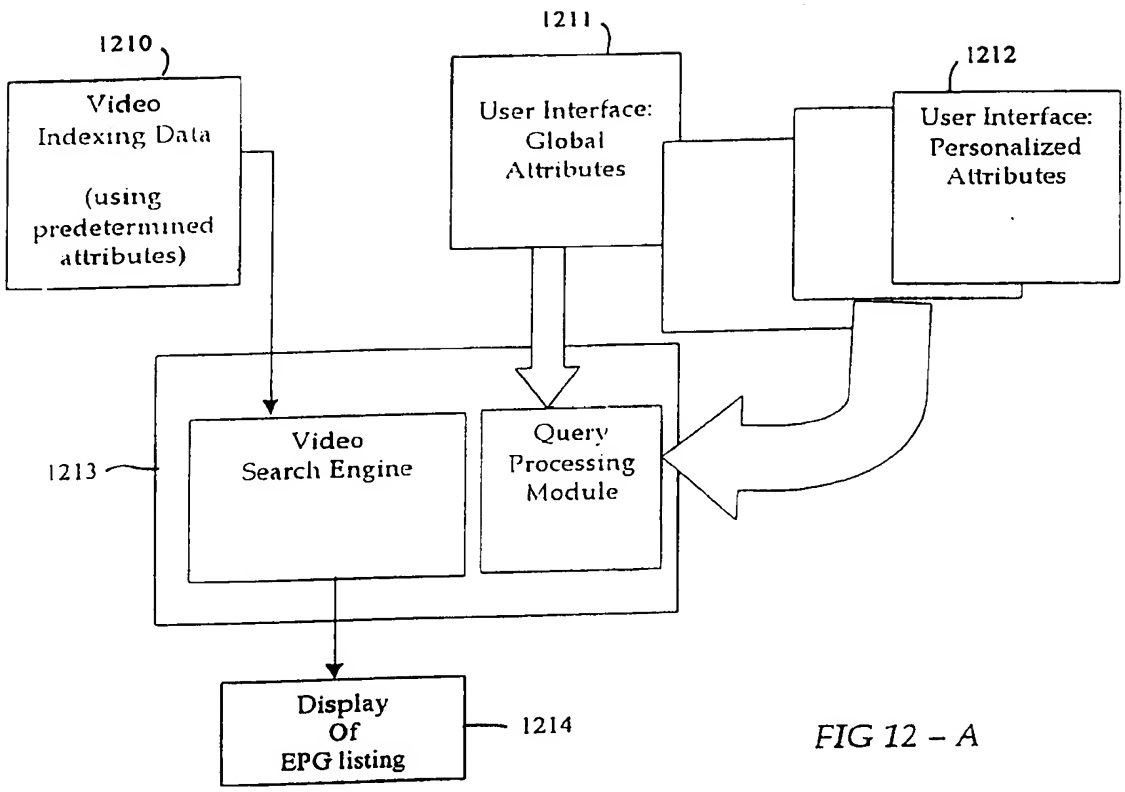

FIG 12 – A

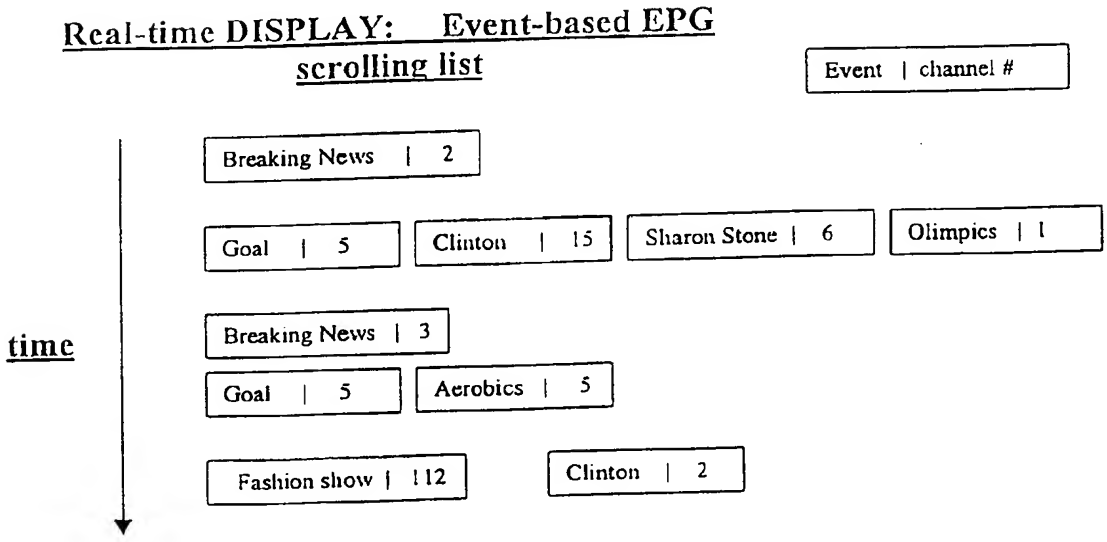

FIG 12 – B

DISPLAY: Channel 5

DATE	TIME	EVENT
4 /17/99	[10:10 - 10:30]	Clinton speech
4 /18/99	[9:25 - 9:40]	Fashion show
4 /20/99	[12:00 - 12:10]	Sharon Stone
4 /20/99	[14:20 - 14:25]	Explosion event

DISPLAY: TIME [10pm-12pm] DATE April 20

Time segment	Event	Channel #
10:10-10:30	Clinton speech	5
10:30-10:35	Stelone & Shooting	6
11:00 – 11:10	Explosion event	13
11:15 – 11:20	Goal Event	220

FIG 12 – C

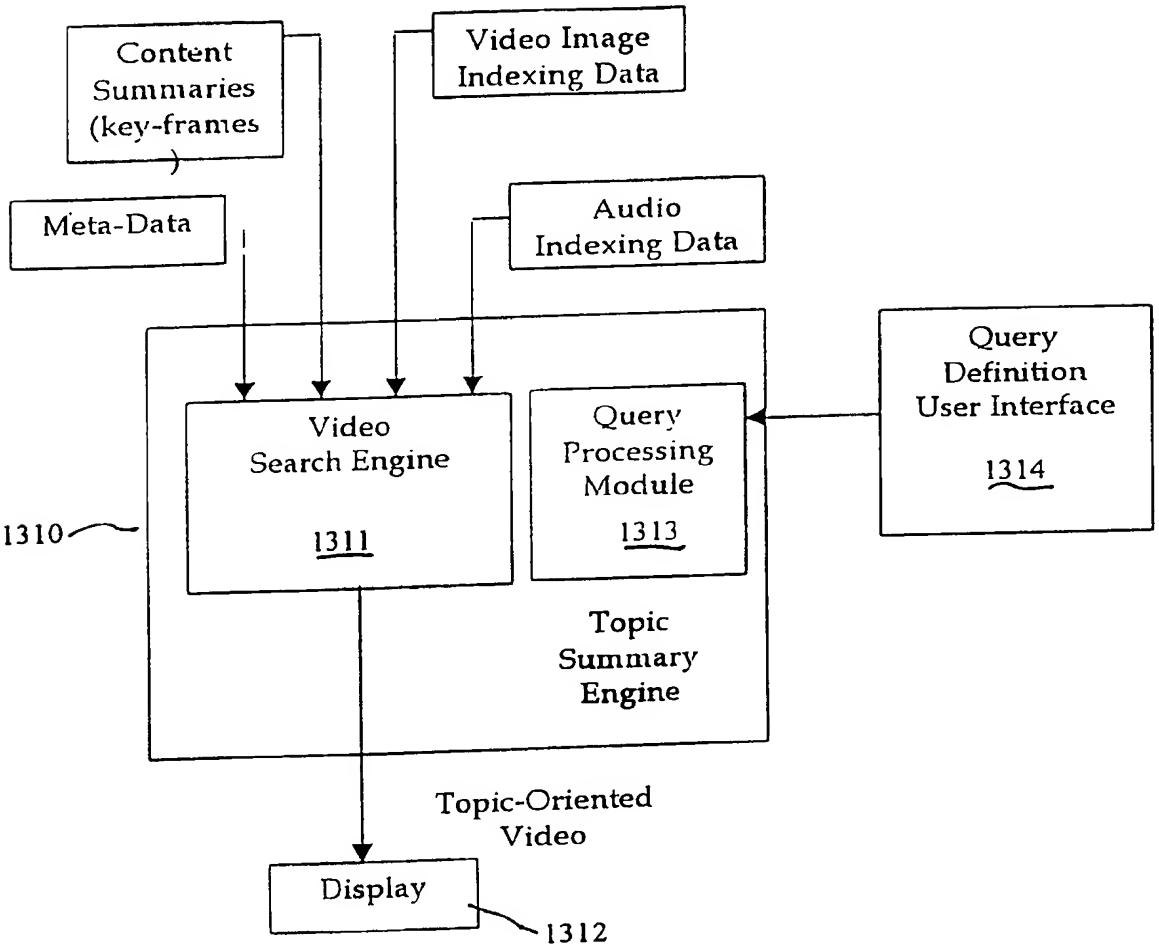
Content Summaries (key-frames)
Video Image Indexing Data
Meta-Data
Audio Indexing Data
Query Definition User Interface
1314
Video Search Engine
1311
Query Processing Module
1313
1310
Topic Summary Engine
Topic-Oriented Video
Display
1312

FIG 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL99/00393

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :H04N 7/10
US CL :345/327
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 345/327; 348/1, 10, 12, 13; 455/5.1, 6.2, 6.3, 4.2

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WEST: AUTOMATICALLY GENERATING, CHANNEL, ATTRIBUTE, INDEXING, MULTICHANNEL, ENCODER, DECODER, EPG , RECEIVING, TRANSMITTING

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	US 5,867,205 A (HARRISON) 02 FEBRUARY 1999, col. 5, line 66 - col. 6, line 5.	1,2,11,14, 16-21, 25-29, 31-34
Y,P	US 5,872,588 A (ARAS et al) 16 FEBRUARY 1999, col. 3, lines 7-27.	1,2,11,14, 16-21, 25-29, 31-34
A,P	US 5,801,747 A (BEDARD) 01 SEPTEMBER 1998, ABSTRACT.	1-36
A,P	US 5,880,768 A (LEMMONS et al) 09 MARCH 1999, ABSTRACT.	1-36

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
02 NOVEMBER 1999

Date of mailing of the international search report
07 DEC 1999

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Form PCT/ISA/210 (second sheet)(July 1992) ★